AD-A106 165 BLACK AND VEATCH KANSAS CITY MO F/G 13/13

NATIONAL DAM SAFETY PROGRAM. BROWN SHANTY LAKE DAM (MO 30197), --ETC(U)

JUL 80 P R ZAMAN, E R BURTON, H L CALLAHAN DACW43-80-C-0074

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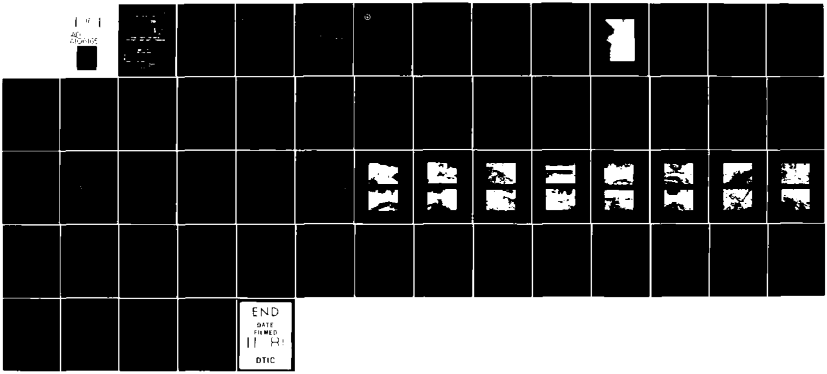

AD A106165

LEVEL II

OSAGE-GASCONADE BASIN

BROWN SHANTY LAKE DAM

GASCONADE COUNTY, MISSOURI

MO 30187

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JULY 1980

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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BROWN SHANTY LAKE DAM

GASCONADE COUNTY, MISSOURI

MO 30197

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT. ST. LOUIS

FOR: STATE OF MISSOURI

JULY 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-PD

SUBJECT: Brown Shanty Lake Dam, MO. I.D. No. 30197
Phase I Inspection Report.

This report presents the results of field inspection and evaluation of the Brown Shanty Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 09 OCT 1980 Date

APPROVED BY : SIGNED — Colonel, CE, District Engineer — 10 OCT 1980 Date

BROWN SHANTY LAKE DAM

GASCONADE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30197

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

JULY 1980

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Brown Shanty Lake Dam
State Located	Missouri
County Located	Gasconade County
Stream	Tributary of Gasconade River
Date of Inspection	15 July 1980

Brown Shanty Lake Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and state agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as a small size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers, failure would threaten lives and property. The estimated damage zone extends approximately one mile downstream of the dam. Within the estimated damage zone are more than nine dwellings. Contents of the estimated downstream hazard zone were verified by the inspection team.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass the probable maximum flood without overtopping but will pass 15 percent of the probable maximum flood. The spillway will pass the flood which has a one percent chance of occurrence in any given year (100-year flood). The spillway design flood recommended by the guidelines is 50 to 100 percent of the probable maximum flood. Considering the hazard zone, the spillway design flood should be 100 percent of the probable maximum flood. The probable maximum flood is defined as the flood discharge which may be expected from the most severe combination of critical meteorologic and hydrologic conditions which are reasonably possible in the region.

Based on visual observations, this dam appears to be in satisfactory condition. Deficiencies visually observed by the inspection team were dense tree and brush cover, extremely steep upstream and downstream slopes, erosion of the upstream slope at the waterline due to wave

action, erosion at the interface of the downstream slope and abutments from surface runoff, seepage on the downstream slope, and animal burrows in the embankment. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition, detailed seepage and stability analyses of the existing dam, as required by the guidelines, should be performed. A detailed report discussing each of these deficiencies is attached.

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Edwin R. Burton

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Missouri E-10137

Harry L. Callahan

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BROWN SHANTY LAKE DAM

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APPENDIX

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Brown Shanty Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with the help of several Federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary of the Gasconade River (see Plate 1). The watershed is an area of low hills with fairly steep rugged terrain consisting of about 95 percent timber and 5 percent gravel roads for access to lakeside cabins and trailers. The dam is approximately 490 feet long along the crest and 34 feet high. The dam crest is 9 feet wide. The downstream face of the dam has a nonuniform slope from the crest to the valley floor below.

(2) The primary spillway is an unlined channel cut in the left abutment. The flow through the spillway is controlled by a trapezoidal concrete weir section with a bottom width of 20 feet and a height of two feet. The weir has a wall thickness of 8 inches. A makeshift diamond mesh screen trash rack about two feet high is set across the weir opening. About 10 feet of the invert downstream of the weir is paved with concrete. The spillway channel section continues to an overfall, then to a channel eroded in rock to the natural stream channel.

(3) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in northwest Gasconade County, Missouri, as indicated on Plate 1. The lake formed by the dam is in an area shown on the United States Geological Survey 7.5 minute series quadrangle map for Pershing, Missouri in Sections 22 and 23 of T44N, R06W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the small size category. A small size dam is classified as having a height less than 40 feet, but greater than or equal to 25 feet and a storage capacity less than 1,000 acre-feet, but greater than or equal to 50 acre-feet.

d. Hazard Classification. The hazard classification assigned by the Corps of Engineers for this dam is as follows: The Brown Shanty Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, agricultural, industrial and commercial facilities, and to important public utilities, main highways, or railroads. For the Brown Shanty Lake Dam the estimated flood damage zone extends approximately one mile downstream of the dam. Within the estimated damage zone are more than nine dwellings. Contents of the estimated downstream hazard zone were verified by the inspection team.

e. Ownership. The dam is owned by the Brown Shanty Lake Association, Orrel Ahlert, President, 9821 Lullabye Lane, Overland, Mo. 67114.

f. Purpose of Dam. The dam forms an 8.6-acre lake used for recreation.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, evaporation, and overflow through the uncontrolled spillway all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 366 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through an unlined trapezoidal spillway channel.

(2) Estimated experienced maximum flood at damsite - Unknown.

(3) Estimated ungated spillway capacity at maximum pool elevation 1,020 cfs (Probable Maximum Flood Pool El. 552.1).

c. Elevation (Feet above m.s.l.).

(1) Top of dam - 549.6 (see Plate 3)

(2) Primary spillway crest - 546.0

(3) Streambed at toe of dam - 516.9

(4) Maximum tailwater - Unknown.

d. Reservoir.

(1) Length of maximum pool - 1,500 feet ± (Probable maximum flood pool level)

(2) Length of normal pool - 1,250 feet ± (Primary spillway crest)

e. Storage (Acre-feet).

(1) Top of dam - 109

(2) Primary spillway crest - 72

(3) Design surcharge - Not available.

f. Reservoir Surface (Acres).

(1) Top of dam - 13.5

(2) Primary spillway crest - 8.6

g. Dam.

(1) Type - Earth embankment

(2) Length - 490 feet

(3) Height - 34 feet ±

(4) Top width - 9 feet

(5) Side slopes - upstream face between 1.0 V on 1.9 H and 1.0 V on 2.1 H, downstream face between 1.0 V on 1.6 H and 1.0 V on 2.5 H (see Plate 4)

(6) Zoning - Unknown.

(7) Impervious core - Unknown.

(8) Cutoff - Unknown.

(9) Grout curtain - Unknown.

h. Diversion and Regulating Tunnel - None.

i. Primary Spillway.

(1) Type - Unlined trapezoidal channel with 20-foot bottom width and two-foot height.

(2) Crest elevation - 546.0 feet m.s.l.

(3) Gates - None.

(4) Upstream channel - Grass lined channel.

(5) Downstream channel - Discharges to a channel eroded in rock then to the natural stream below the dam.

j. Emergency Spillway - None.

k. Regulating Outlets - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data were not available.

2.2 CONSTRUCTION

Construction records were unavailable.

2.3 OPERATION

Operational records and documentation of past floods were unavailable.

2.4 GEOLOGY

The site of the dam and reserovir is located in steep-sided valley. The dam impounds an intermittent tributary of the Gasconade River.

No information was available on the soils of the area of the dam and reservoir. The bedrock consists of sandstone, chert and dolomite of the Roubidoux Formation of the Ordovician System.

2.5 EVALUATION

a. Availability. No engineering data were available.

b. Adequacy. No engineering data were available. Thus, an assessment of the design, construction, and operation could not be made. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The validity of the design, construction, and operation could not be determined due to the lack of engineering data.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Brown Shanty Lake Dam was made on 15 July 1980. The inspection team consisted of Edwin Burton, team leader; Robert Pinker, geologist; Gary Van Riessen, geotechnical engineer; and Andrew Dywan, civil engineer. The dam is in satisfactory condition. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following conditions at the dam. No cracking, sliding, sloughing or other signs of settlement were observed. However, the upstream and downstream slopes of the embankment are extremely steep except at the center portion of the downstream slope which was widened to a flatter slope. No instruments to measure the performance of the dam were located.

A seepage area was observed on the downstream slope near the center of the embankment several feet up the slope from the downstream toe. Flow of approximately 1 gpm was observed at the upper end of the seepage area. The flow area at the upper end also had a deposit of an iron oxide coloration. As the flow proceeded down the slope, it appeared that the flow increased it reached the downstream toe. No toe drains or relief wells were observed.

The dam crest has a mowed grass/weed cover with some worn spots, probably due to foot traffic. The embankment material contains rock which provides some slope protection, but wave action erosion was observed on the upstream slope. The upstream and downstream slopes are covered with many large trees and brush. Some trees 4 to 8 inches in diameter were recently cut and some burning of standing brush, trees and stumps was attempted on the downstream slope.

Some erosion gullies were observed at both the left and right abutment interface with the embankment.

As previously mentioned, the center portion of the dam has been widened to a flatter downstream slope. This materal containing less rock than the steeper sloped right and left sections of the dam could indicate that this embankment widening may have been done to repair damage due to overtopping. No other evidence was found to indicate that the embankment had ever been overtopped.

There was evidence that a maintenance program was in effect which includes mowing of the crest grass/weeds and the cutting of trees on the downstream slope. A few animal burrows were observed on the crest and downstream slope.

c. Appurtenant Structures. The inspection team observed the following items pertaining to the appurtenant structures. The primary spillway is an unlined trapezoidal channel cut in the left abutment with a concrete control weir. There was no evidence of erosion in the spillway itself or upstream and downstream of the spillway. The spillway was considered to be in good condition. It should be noted that an abnormally large spillway discharge would probably not damage the embankment due to a natural training berm which separates the spillway channel from the embankment.

There was no development in the spillway area which would suffer damage due to flow through the spillway.

d. Geology. The soils in the area of the dam and reservoir consist of silty, sandy clay with cobbles of chert and sandstone. The soils were classified as low-plastic clay (CL). The soils are located along the slopes of the reservoir and along the sides of the spillway and downstream of the dam.

Outcrops of sandstone, chert and dolomite were observed in the channel of the spillway. The sandstone, dolomite and chert are interbedded. Beds are approximately 18 inches thick with closed bedding planes. No joints were observed in the rock strata. Numerous blocks of sandstone and chert are present on the downstream slope of the embankment.

Samples of the embankment were taken near the center of the upstream crest using an Oakfield sampler. The materials in the samples consisted of silty, sandy clay of low-plasticity classified as (CL). Based on these samples and visual observations, it is anticipated that the embankment consists of silty, sandy clay classified as (CL).

The abutments and foundation of the dam are anticipated to consist of interbedded sandstone, chert and dolomite overlain by thin residual silty, sandy clay soil with sandstone and chert cobbles.

e. Reservoir Area. No slumping or slides of the reservoir banks were observed. The upstream channel to the lake contains some minor debris and a few trees. The lake was noted to be clean with no siltation.

f. Downstream Channel. The spillway discharges to a channel eroded in rock, then to the natural streambed.

3.2 EVALUATION

The various deficiencies observed at the time of the inspection are not believed to represent an immediate safety hazard. They do, however, warrant monitoring and control.

The potential for sloughing, erosion, or sliding of embankment material is enhanced by the presence of the relatively steep side slopes and the narrow crest.

The growth of trees and brush and the uncut grass, if allowed to go unchecked, could cause deterioration of the embankment. The roots of trees can loosen the embankment material and also can leave voids through which water can pass. Brush on the dam prevents inspection of the embankment and kills the smaller grasses whose roots are more effective in protecting the surface soil of the slope from erosion. The brush and tall uncut grass provides habitat for burrowing animals which can damage the embankment.

The area of seepage on the downstream slope which was observed should be monitored regularly for quality and quantity. Seepage can cause internal erosion creating cavities and underground channels, thereby weakening the embankment and/or abutments.

The erosion gullies at the left and right abutment interfaces with the embankment should be repaired.

The absence of riprap on the upstream slope of the dam has resulted in wave action erosion. If not corrected wave action will continue to erode the embankment and could lead to slope stability problems.

Burrowing animals will continue to damage the embankment if no program is undertaken to eliminate them. Piping failure of the embankment has resulted in similar small earth dams due to burrowing animal damage.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The pool is primarily controlled by rainfall, runoff, evaporation, transpiration, and capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM

There was evidence that a maintenance program was in effect which includes the mowing of the crest grass/weeds and the cutting of trees on the downstream slope.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no existing warning system or preplanned scheme for alerting downstream residents for this dam.

4.5 EVALUATION

A maintenance program should continue to include mowing the grass cover on the embankment in order to discourage animal burrowing.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. No design data were available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Pershing Quadrangle Map. The dam layout is from a survey made during the inspection.

c. Visual Observations.

(1) The primary spillway appears to be in good condition. The lake level at the time of the inspection (El. 544.6) was below the principal spillway crest level. There were no obstructions to flow in the downstream channel.

(2) There is no emergency spillway for this dam.

(3) Spillway discharges do not endanger the integrity of the dam.

d. Overtopping Potential. The spillway will not pass the probable maximum flood without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway will pass 15 percent of the probable maximum flood without overtopping the dam. The spillway will pass the one percent chance flood estimated to have a peak outflow of 470 cfs developed by a 24-hour, one percent chance rainfall. According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of small size should pass 50 to 100 percent of the probable maximum flood. Considering the downstream hazard, the appropriate spillway design flood should be 100 percent of the probable maximum flood. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 1,310 cfs of the total discharge from the reservoir of 2,160 cfs. The estimated duration of overtopping is 3.9 hours with a maximum height of 1.6 feet. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 3,450 cfs of the total discharge from the reservoir of 4,470 cfs. The estimated duration of overtopping is 5.9 hours with a maximum height of 2.5 feet. The embankment could be jeopardized should overtopping occur for these periods of time.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately one mile downstream

of the dam. More than nine dwellings could be severely damaged and lives could be lost should failure of the dam occur. Contents of the estimated downstream hazard zone were verified by the inspection team. There does not appear to be any flood plain regulations or other constraints in force to limit future downstream development.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operational records exist.

d. Postconstruction Changes. It is apparent, as noted in section 3.1.b, that repairs to the dam may have been made subsequent to overtopping. When any repairs were made is unknown.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone. The seismic stability of an earth dam is dependent upon a number of factors: embankment and foundation material classifications and shear strengths; abutment materials, conditions, and strengths; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the stability analysis required by the guidelines.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several conditions observed during the visual inspection by the inspection team should be monitored and/or controlled. These are erosion on the upstream slope and at both abutment/embankment interfaces, the seepage area on the downstream slope, the dense growth of grass/weeds, brush, and trees on the embankment, and animal burrows in the embankment. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

b. Adequacy of Information. Due to the absence of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. It is the opinion of the inspection team that a program should be developed as soon as possible to implement remedial measures recommended in paragraph 7.2b. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II. The Phase I investigation does not raise any serious questions relating to the safety of the dam nor does it identify any serious dangers which would require a Phase II investigation. However, the additional analyses noted in paragraph 2.5b are necessary for compliance with the guidelines.

e. Seismic Stability. This dam is located in Seismic Zone 1. Adequate description of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability. An assessment of the seismic stability should be included as part of the recommended stability analysis.

7.2 REMEDIAL MEASURES

a. Alternatives. The primary spillway size and/or height of the dam would need to be increased or the lake level would need to be permanently lowered to increase available flood storage in order to pass the spillway design flood.

b. Operation and Maintenance Procedures. The following operation and maintenance procedures are recommended and should be carried out under the direction of a professional engineer experienced in the design, construction, and maintenance of earth dams.

(1) Riprap should be placed on the upstream face of the dam at the normal lake level to prevent erosion of the embankment material.

(2) The seepage area noted during the visual inspection should be closely monitored and documented as to quantity of flow. Any significant changes should be evaluated.

(3) An improved maintenance program to remove and control the growth of brush and trees on the embankment should be developed. Grass/weed cover on the embankments should be cut periodically.

(4) The erosion gullies on the downstream slope at the interface of the embankment and the right and left abutments should be backfilled with suitable material and compacted. Paved ditches or other slope protection may be required to control the concentrated runoff.

(5) The animal burrows in the embankment should be corrected since they can lead to piping. Control measures should be implemented under the direction of a qualified engineer to discourage increased animal activity in the area. The embankment slope should be monitored during this repair.

(6) Seepage and stability analyses should be performed.

(7) A detailed inspection of the dam should be made periodically. This inspection should include measurement of seepage flows and analyzing water samples taken from the seep and lake. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increase.

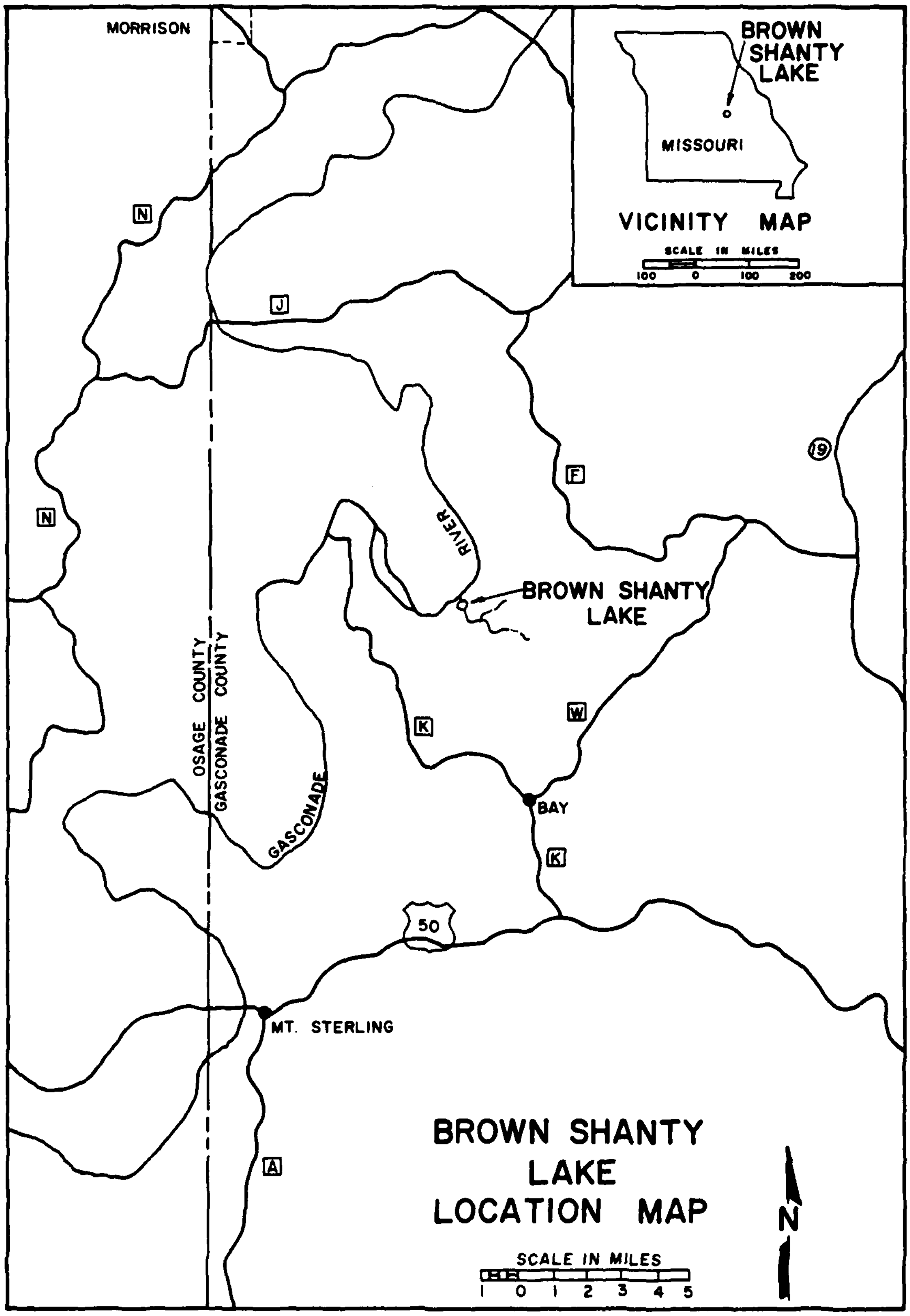
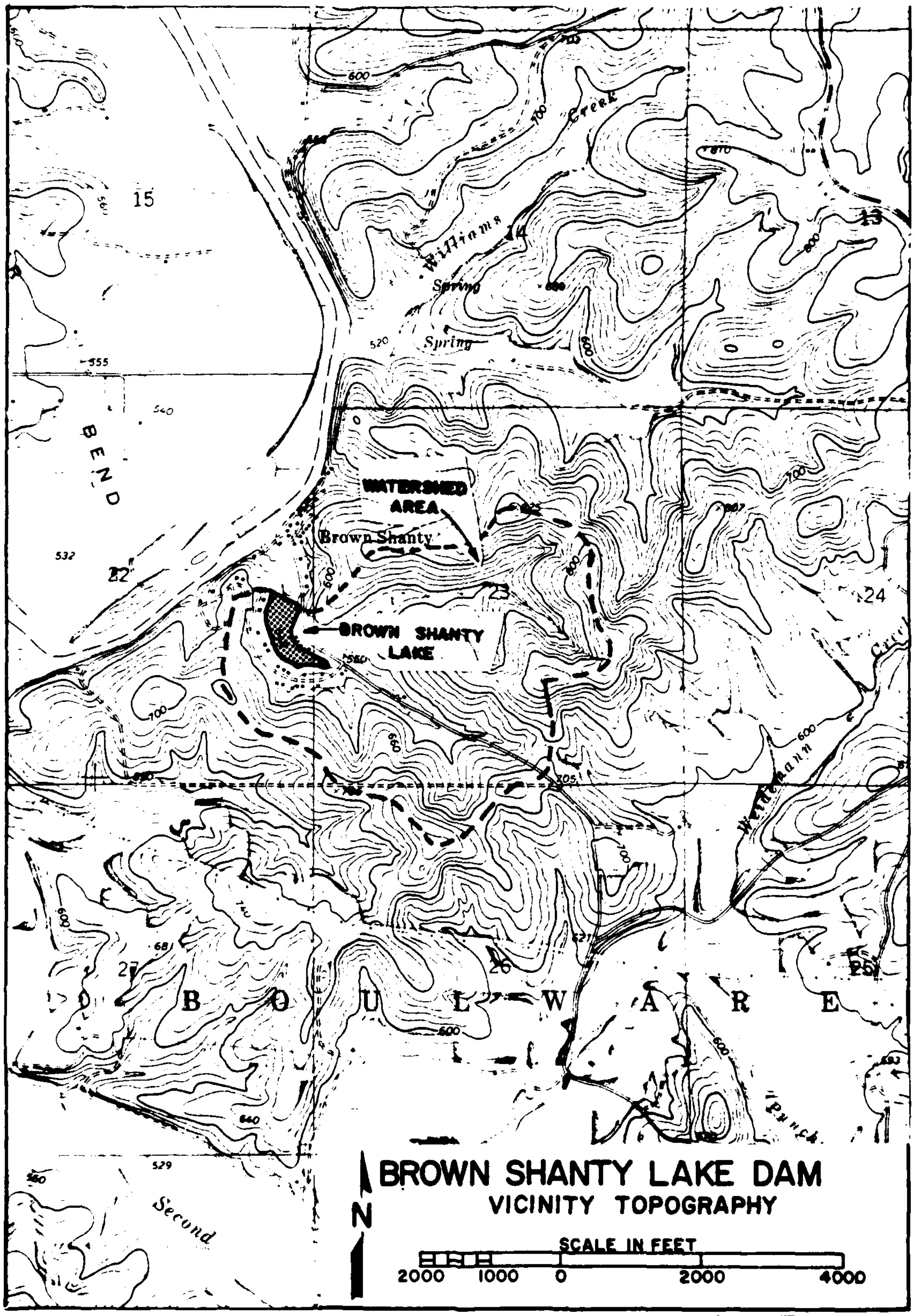
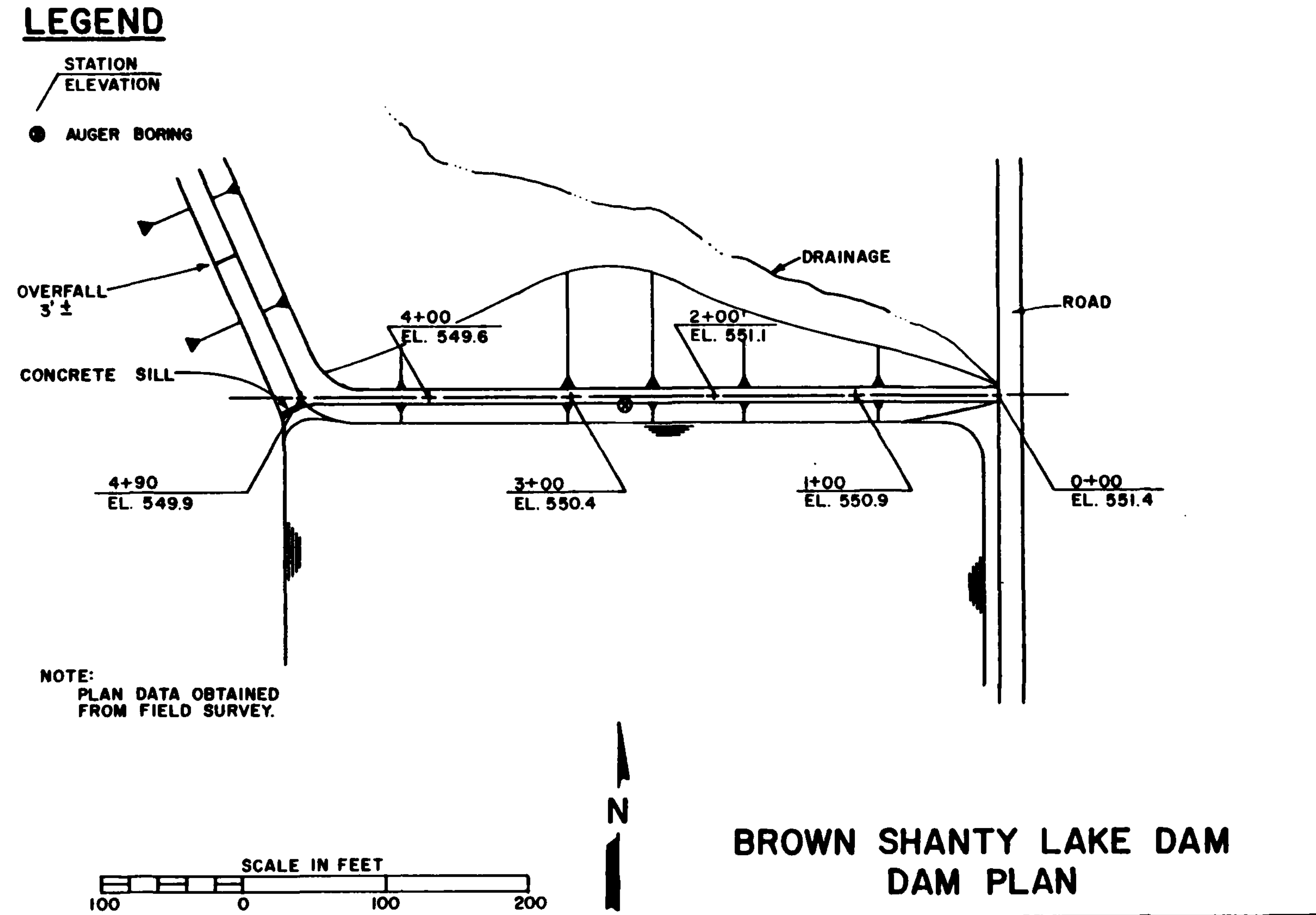

MORRISON
BROWN SHANTY LAKE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200
N
J
N
F
19
RIVER
BROWN SHANTY LAKE
OSAGE COUNTY
GASCONADE COUNTY
K
W
GASCONADE
BAY
K
50
MT. STERLING
A
BROWN SHANTY LAKE LOCATION MAP
SCALE IN MILES
1 0 1 2 3 4 5
N

PLATE I



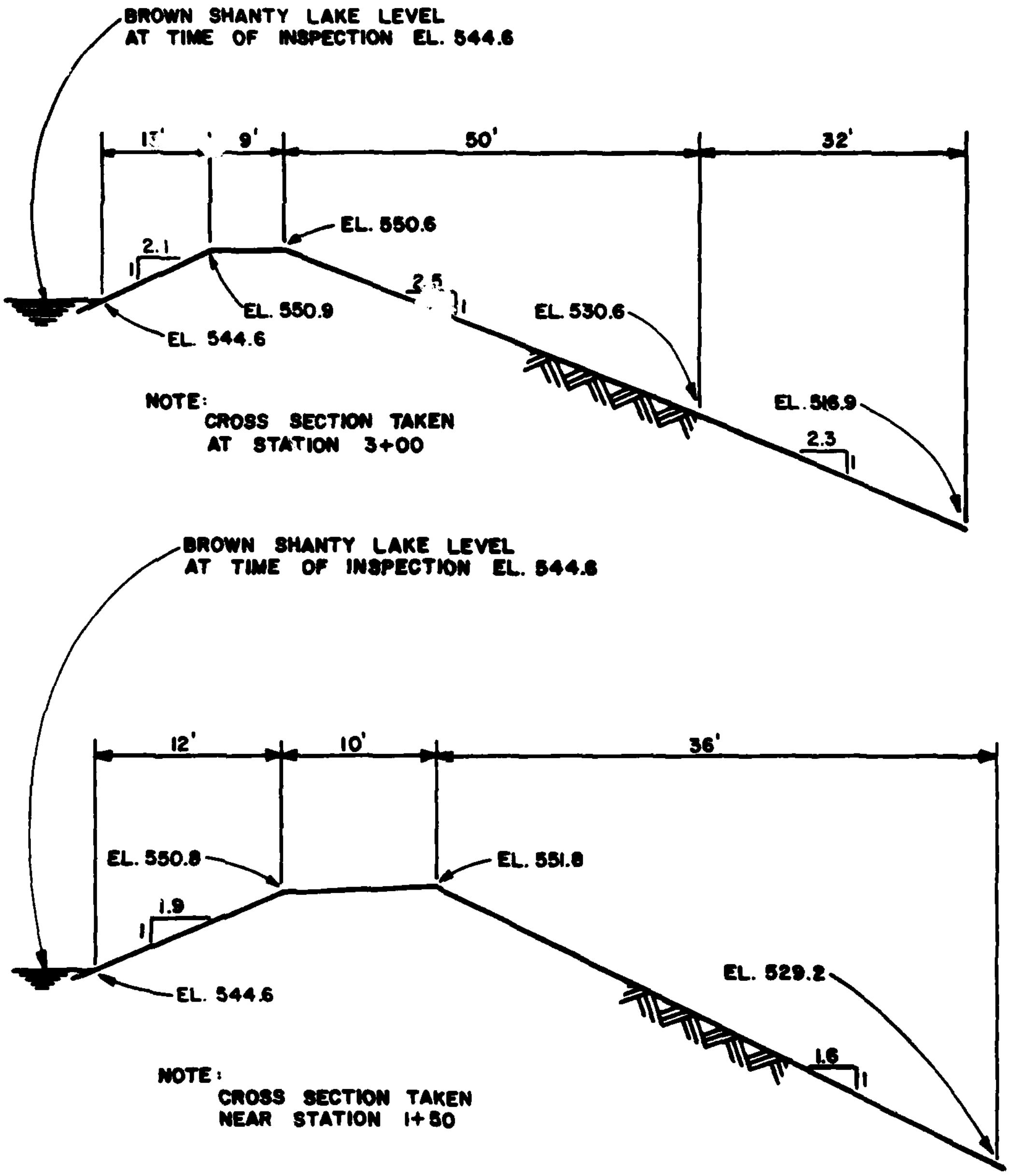
BROWN SHANTY LAKE DAM
VICINITY TOPOGRAPHY
N
SCALE IN FEET
2000 1000 0 2000 4000
WATERSHED AREA
Brown Shanty
BROWN SHANTY LAKE
Williams Creek
Spring
Spring
BEND
B O U L W A R E
Second
15
14
13
22
23
24
27
26
25

PLATE 2



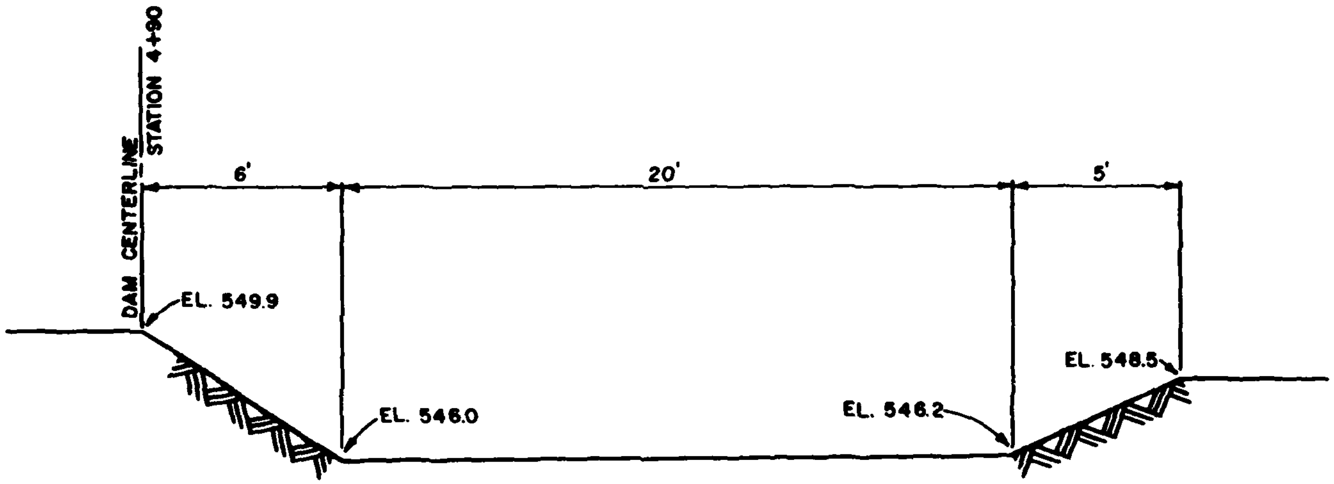
NOTE:
PLAN DATA OBTAINED
FROM FIELD SURVEY.

BROWN SHANTY LAKE DAM
DAM PLAN



BROWN SHANTY LAKE DAM
DAM CROSS SECTIONS

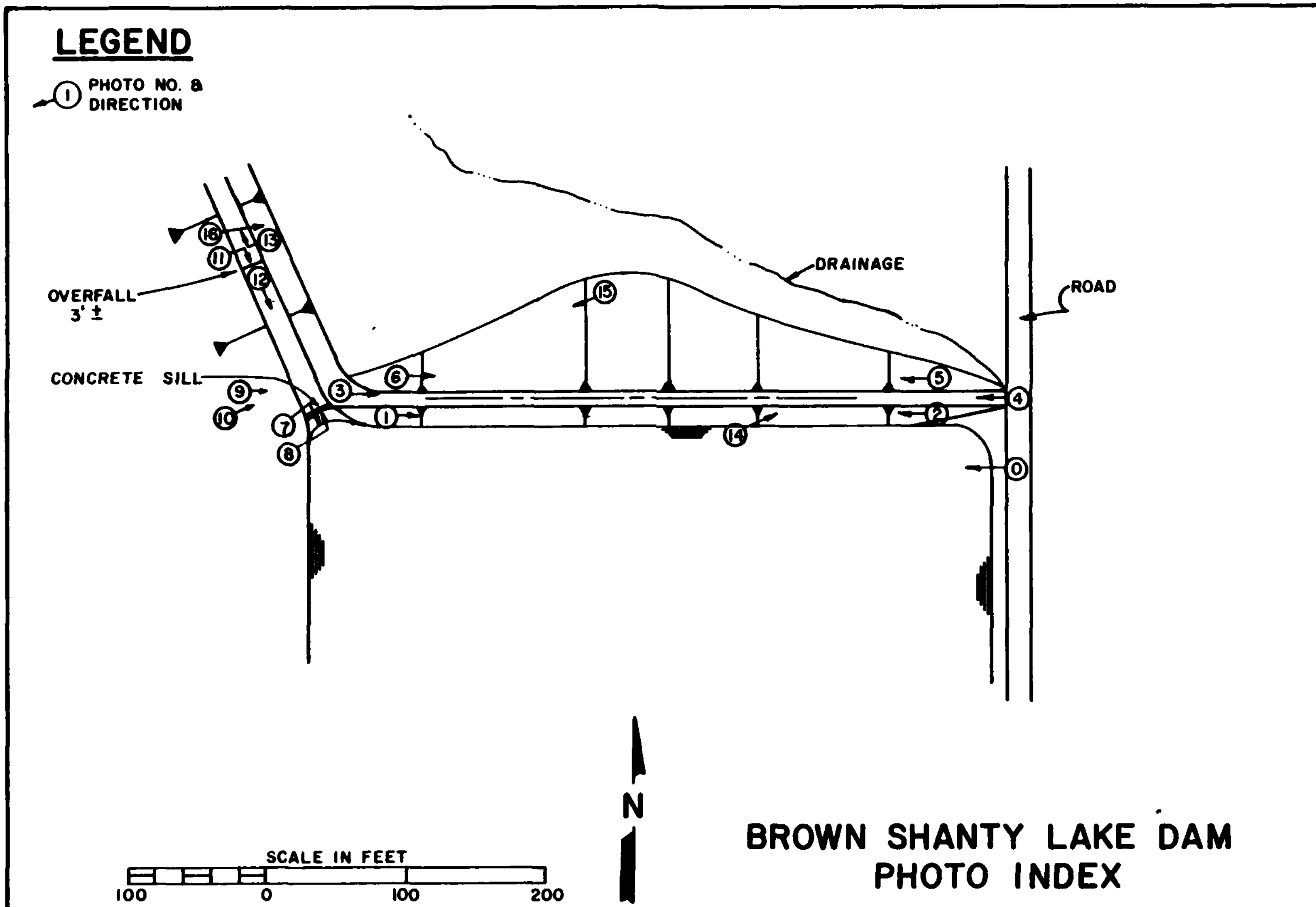
PLATE 4



NOTE:
CROSS SECTION TAKEN
NEAR DAM CENTERLINE
STATION 4+90 LOOKING
UPSTREAM

BROWN SHANTY LAKE DAM
PRIMARY SPILLWAY CROSS SECTION

PLATE 5



BROWN SHANTY LAKE DAM
PHOTO INDEX

PLATE 6

PHOTO 1: UPSTREAM FACE OF DAM LOOKING EAST

PHOTO 2: UPSTREAM FACE OF DAM LOOKING WEST

PHOTO 3: CREST OF DAM LOOKING EAST

PHOTO 4: CREST OF DAM LOOKING WEST

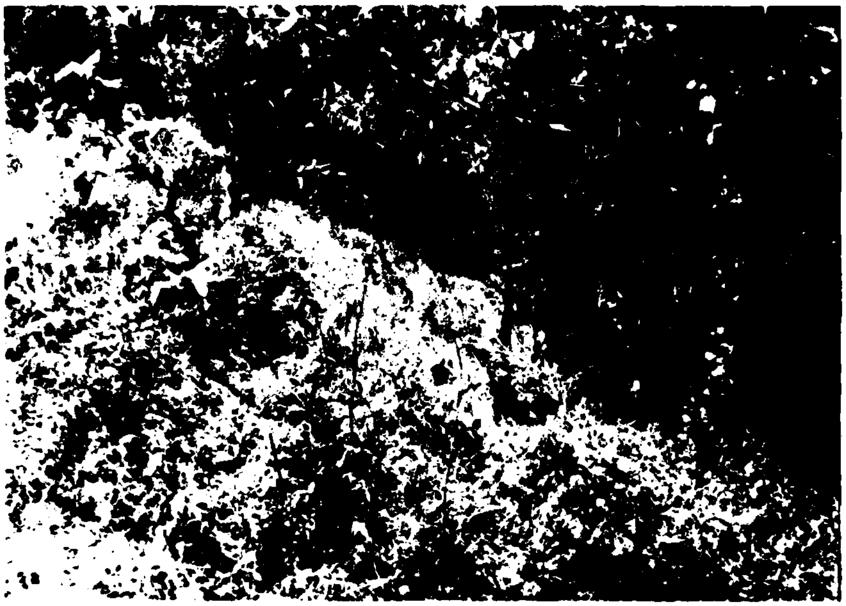


PHOTO 5: DOWNSTREAM SLOPE OF DAM LOOKING EAST

PHOTO 6: DOWNSTREAM SLOPE OF DAM LOOKING WEST

PHOTO 7: SPILLWAY APPROACH LOOKING UPSTREAM FROM CONTROL SILL

PHOTO 8: SPILLWAY CONTROL SILL LOOKING DOWNSTREAM

PHOTO 9: OVERVIEW OF SPILLWAY AND DAM

PHOTO 10: SPILLWAY CONTROL SILL

PHOTO 11: SPILLWAY CHANNEL OVERFALL

PHOTO 12: SPILLWAY CHANNEL LOOKING UPSTREAM FROM OVERFALL

PHOTO 13: SPILLWAY CHANNEL LOOKING DOWNSTREAM FROM OVERFALL

PHOTO 14: ANIMAL BURROW IN UPSTREAM FACE

PHOTO 15: ANIMAL BURROW IN DOWNSTREAM FACE

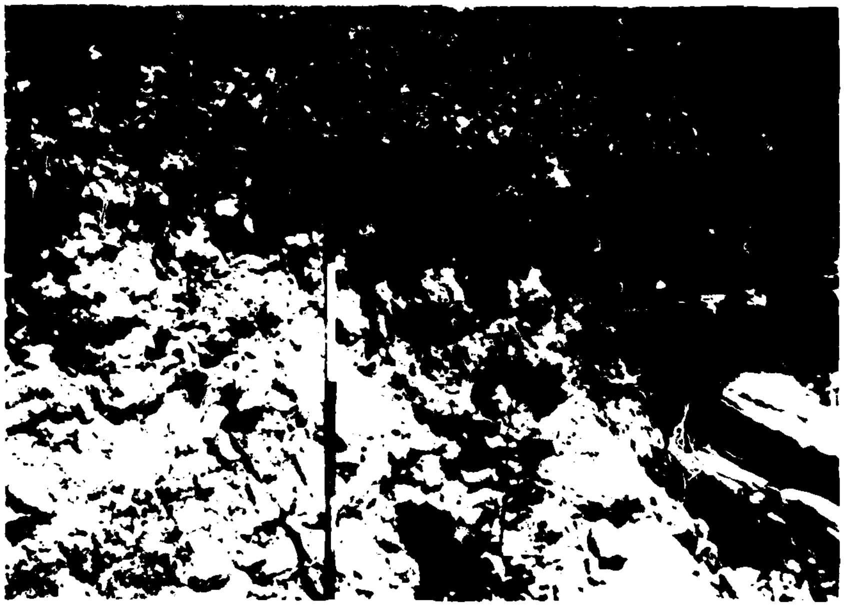


PHOTO 16: NATURAL MATERIAL EXPOSED IN SPILLWAY CHANNEL

APPENDIX A

HYDROLOGIC AND HYDRAUIIC ANALYSES

HYDROLOGIC AND HYDRAULIC ANALYSES

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was determined using the computer program HEC-1 (Dam Safety Version) (1).

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33" (HMR-33). Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm was determined according to the procedures outlined in HMR-33 and EM 1110-2-1411. The Jefferson City, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corp of Engineers, was used when the one percent chance probability flood was routed through the reservoir and spillway.

The synthetic unit hydrograph for the watershed was developed by the computer program using the Soil Conservation Service (SCS) method. The parameters for the unit hydrograph are shown in Table 1.

The SCS curve number (CN) method was used in computing the infiltration losses for the rainfall-runoff relationship. The CN values used, and the result from the computer output, are shown in Table 2.

The reservoir routing was performed using the Modified Puls Method. The initial reservoir pool elevation for the routing of each storm was determined to be equivalent to the crest elevation of the primary spillway at elevation 546.0 feet m.s.l. in accordance with antecedent storm conditions preceding the one percent probability and probable maximum storms outlined by the U.S. Army Corps of Engineers, St. Louis District (2). The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation, surface area, storage, and discharge relationships shown in Table 3.

The rating curve for the spillway is shown in Table 4. The flow over the crest of the dam and through the primary spillway was determined using the non-level dam crest option ($L and $V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir.

The result of the routing analysis indicates that 15 percent of the PMF will not overtop the dam.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5.

The computer input data and a summary of the output data are presented at the back of this appendix.

TABLE 1

SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	366 acres	
Hydraulic Length of Watercourse (ℓ)	5,100 feet	
Hydrologic Soil Cover Complex Number (CN')	85 (AMC III)	70 (AMC II)
Average Watershed Land Slope (Y)	6.2%	
Lag Time (L_g)	0.40 hours (AMC III)	0.63 hours (AMC II)
Time of concentration (T_c)	0.67 hours (AMC III)	1.05 hours (AMC II)
Duration (D)	5 min. (AMC III) (use 5 minutes in each case)	8 min. (AMC II)

Time (Min.) *	Discharge (cfs) * AMC II	Discharge (cfs) * AMC III
0	0	0
5	19	57
10	59	176
15	113	371
20	190	549
25	284	620
30	356	605
35	398	526
40	410	417
45	402	288
50	370	211
55	331	157
60	283	117
65	224	85
70	178	63

* From HEC-1 computer output

TABLE 1
(Continued)

FORMULAS USED:

$$L_g = \frac{\ell^{0.8} \times (S + 1)^{0.7}}{1,900 \times Y^{0.5}} \qquad (3)$$

$$S = \frac{1000}{CN'} - 10$$

$$T_c = L_g/0.6$$

$$D = 0.133\ T_c$$

TABLE 2

RAINFALL-RUNOFF VALUES

Selected Storm Event	Storm Duration (Hours)	Rainfall (Inches)	Runoff (Inches)	Loss (Inches)
PMP	24	32.50	30.47	2.03
1% Probability	24	7.44	3.99	3.45

Additional Data:

1) No information on soil associations was available for this watershed.
   100 percent of drainage area in hydrologic soil group C.
   5 percent of the land use was rural development.
   95 percent of the land use was timberland (3).
2) SCS Runoff Curve CN = 85 (AMC III) for the PMF.
3) SCS Runoff Curve CN = 70 (AMC II) for the one percent probability flood.

TABLE 3

ELEVATION, SURFACE AREA, STORAGE, AND DISCHARGE RELATIONSHIPS

Elevation (feet-MSL)	Lake Surface Area (acres)	Lake Storage (acre-ft)	Spillway Discharge (cfs)
*546.0	8.6	72	0
**549.6	13.5	109	513

*Primary spillway crest elevation
**Top of dam elevation

The relationships in Table 3 were developed from the Pershing, Missouri. 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

Reservoir Elevation (ft-msl)	Primary Spillway Discharge (cfs)
*546.0	0
547.0	56
548.0	179
549.0	376
**549.6	513

*Primary Spillway Crest Elevation
**Top of Dam Elevation

METHOD USED:

Primary spillway releases were computed by HEC-1 from spillway geometry data input on $L and $V cards. Discharge through the primary spillway for the probable maximum flood and 50 percent of the probable maximum flood was determined by the equations for flow over a non-level crest.

$$d_c = 2/3\ (H_m + 1/4\ \Delta Y)$$

$$A = 1/2\ T\ (2d_c - \Delta Y)$$

$$Q = (A^3 g/T)^{0.5}$$

where:

d_c = critical depth (feet)

H_m = available specific energy which is taken to be the height of the water surface in the reservoir above the bottom of the section (feet)

ΔY = change in elevation across the section (feet)

A = flow area (sq. ft.)

T = top width (feet)

Q = flow (cfs)

g = 32.2 ft/sec^2 = acceleration due to gravity.

TABLE 5

RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (CFS)	Peak Lake Elevation (ft.-MSL)	Total Storage (AC.-FT.)	Peak Outflow (CFS)	Depth (ft.) Over Top of Dam
-	0	*546.0	72	0	-
0.15	678	549.3	105	435	0
0.50	2,261	551.2	129	2,156	1.6
1.00	4,523	552.1	141	4,471	2.5

* Primary spillway crest elevation

BIBLIOGRAPHY

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1), Dam Safety Version, July 1978, Davis, California.

(2) U.S. Army Corps of Engineers, St. Louis District, Hydrologic/ Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams, 12 December 1979.

(3) U.S. Department of Agriculture, Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, August 1972.

(4) U.S. Department of Agriculture, Soil Conservation Service, Soil Survey Interpretations and Field Maps, 1980.

(5) Mary H. McCracken, Missouri Division of Geological Survey, Geologic Map of Missouri, 1961.

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  06 FEB 80
**********************************
          A1MISSOURI DAM INSPECTION PROGRAM
          A2ST. LOUIS DISTRICT US ARMY CORPS OF ENGR
          A3BROWN SHANTY LAKE DAM - PMF
          B    288       0       5       0       0       0       0       0       0       0
          B1     5
          J      1       4       1
          J10.15   0.2     0.5     1.0
          K      0       1                               3       1
          K1   BROWN SHANTY LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
          M      1       2     .57                       1
          P            25.0    101     120     130
          T                                                   -1     -85
          W2             .4
          X                      1
          K      1       2                                       1
          K1   ROUTE THROUGH SPILLWAY
          Y                              1       1
          Y1     1                                        -546.0
          $A0.0   8.6     24.8    53.1
          $E521.0 546.0   560.0   580.0
          $$546.0
          $D549.6
          $L0.    20.     29.     40.     106.    169.    238.    312.    483.    546.
          $V546.0 546.2   548.5   549.6   549.7   549.8   550.4   550.9   551.1   551.4
          K     99
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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 80
******************************
                    MISSOURI DAM INSPECTION PROGRAM
                    ST. LOUIS DISTRICT US ARMY CORPS OF ENGR
                    BROWN SHANTY LAKE DAM - PMF

                                    JOB SPECIFICATION
          NQ     NHR    NMIN    IDAY    IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         288       3       5       0      0       0       0       0       0       0
                                 JOPER    NWT   LROPT   TRACE
                                     5      0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                                NPLAN= 1 NRTIO= 4 LRTIO= 1
            RTIOS=    .15    .20    .50   1.00

   *********     *********     *********     *********     *********

                              SUB-AREA RUNOFF COMPUTATION

             BROWN SHANTY LAKE (24 HR. PROBABLE MAXIMUM RUNOFF)
                      ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME  ISTAGE   IAUTO
                          1       0       0       0      0      3       1       0       0

                                    HYDROGRAPH DATA
              IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                  1      2     .57     .00     .57    1.00    .000       0       0       0

                                      PRECIP DATA
                       SPFE     PMS      R6     R12     R24     R48     R72     R96
                        .00   25.02  101.00  120.00  130.00     .00     .00     .00

                                       LOSS DATA
        LROPT  STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
            0    .00    .00   1.00    .00    .00   1.00  -1.00 -85.00    .00    .00

          CURVE NO = -85.00  WETNESS =  -1.00  EFFECT CN =  85.00

                                  UNIT HYDROGRAPH DATA
                                TC=   .00   LAG=   .40

                                     RECESSION DATA
                       STRTQ=    .00   QRCSN=    .00   RTIOR= 1.00

          UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC=    .00 HOURS, LAG=   .40  VOL= 1.00
         57.     176.     371.     547.     620.     605.     526.     417.     288.     211.
        157.     117.      85.      63.      46.      33.      25.      18.      13.      10.
          7.       6.       4.       3.       2.       1.
```

57.	176.	371.	542.	620.	605.	526.	417.	288.	211.
157.	117.	85.	63.	46.	33.	25.	18.	13.	10.
7.	6.	4.	3.	2.	1.				

B L A C K   &   V E A T C H   PROJECT 9166.   DATE 8 AUG 80   PAGE 5

FLOOD HYDROGRAPH PACKAGE - HEC-1   PROGRAM H21/02-CU   TIME 11:27:11   CASE PMF

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	.00	.01	0.	1.01	12.05	145	.21	.20	.01	279.
1.01	.10	2	.01	.00	.01	0.	1.01	12.10	146	.21	.20	.01	304.
1.01	.15	3	.01	.00	.01	0.	1.01	12.15	147	.21	.20	.01	355.
1.01	.20	4	.01	.00	.01	0.	1.01	12.20	148	.21	.20	.01	430.
1.01	.25	5	.01	.00	.01	0.	1.01	12.25	149	.21	.20	.01	515.
1.01	.30	6	.01	.00	.01	0.	1.01	12.30	150	.21	.20	.01	599.
1.01	.35	7	.01	.00	.01	0.	1.01	12.35	151	.21	.20	.01	672.
1.01	.40	8	.01	.00	.01	0.	1.01	12.40	152	.21	.20	.01	731.
1.01	.45	9	.01	.00	.01	0.	1.01	12.45	153	.21	.20	.01	772.
1.01	.50	10	.01	.00	.01	0.	1.01	12.50	154	.21	.20	.01	802.
1.01	.55	11	.01	.00	.01	0.	1.01	12.55	155	.21	.20	.01	826.
1.01	1.00	12	.01	.00	.01	0.	1.01	13.00	156	.21	.20	.01	844.
1.01	1.05	13	.01	.00	.01	0.	1.01	13.05	157	.25	.24	.01	859.
1.01	1.10	14	.01	.00	.01	0.	1.01	13.10	158	.25	.24	.01	877.
1.01	1.15	15	.01	.00	.01	0.	1.01	13.15	159	.25	.25	.01	900.
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1.01	1.25	17	.01	.00	.01	0.	1.01	13.25	161	.25	.25	.01	959.
1.01	1.30	18	.01	.00	.01	0.	1.01	13.30	162	.25	.25	.01	988.
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1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.25	.25	.01	1057.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.25	.25	.01	1066.
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1.01	2.50	34	.01	.00	.01	3.	1.01	14.50	178	.32	.31	.00	1333.
1.01	2.55	35	.01	.00	.01	3.	1.01	14.55	179	.32	.31	.00	1344.
1.01	3.00	36	.01	.00	.01	4.	1.01	15.00	180	.32	.31	.00	1352.
1.01	3.05	37	.01	.00	.01	5.	1.01	15.05	181	.19	.19	.00	1351.
1.01	3.10	38	.01	.00	.01	6.	1.01	15.10	182	.38	.38	.00	1345.
1.01	3.15	39	.01	.00	.01	6.	1.01	15.15	183	.38	.38	.00	1337.
1.01	3.20	40	.01	.00	.01	7.	1.01	15.20	184	.58	.57	.01	1354.
1.01	3.25	41	.01	.00	.01	8.	1.01	15.25	185	.67	.67	.01	1423.
1.01	3.30	42	.01	.00	.01	9.	1.01	15.30	186	1.63	1.62	.01	1611.
1.01	3.35	43	.01	.00	.01	9.	1.01	15.35	187	2.69	2.67	.02	2031.
1.01	3.40	44	.01	.00	.01	10.	1.01	15.40	188	1.06	1.05	.01	2697.
1.01	3.45	45	.01	.00	.01	11.	1.01	15.45	189	.67	.67	.00	3521.
1.01	3.50	46	.01	.00	.01	12.	1.01	15.50	190	.58	.57	.00	4202.
1.01	3.55	47	.01	.00	.01	12.	1.01	15.55	191	.38	.38	.00	4523.
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1.01	4.05	49	.01	.00	.01	14.	1.01	16.05	193	.29	.29	.00	4172.
1.01	4.10	50	.01	.00	.01	14.	1.01	16.10	194	.29	.29	.00	3682.
1.01	4.15	51	.01	.00	.01	15.	1.01	16.15	195	.29	.29	.00	3144.
1.01	4.20	52	.01	.00	.01	16.	1.01	16.20	196	.29	.29	.00	2708.
1.01	4.25	53	.01	.00	.01	16.	1.01	16.25	197	.29	.29	.00	2362.

1.01	4.10	50	.01	.00	.01	14.	1.01	16.10	194	.29	.29	.00	3662.
1.01	4.15	51	.01	.00	.01	15.	1.01	16.15	195	.29	.29	.00	3144.
1.01	4.20	52	.01	.00	.01	16.	1.01	16.20	196	.29	.29	.00	2708.
1.01	4.25	53	.01	.00	.01	16.	1.01	16.25	197	.29	.29	.00	2362.

1.01	4.30	54	.01	.00	.01	17.	1.01	16.30	198	.29	.29	.00	2087.
1.01	4.35	55	.01	.00	.01	17.	1.01	16.35	199	.29	.29	.00	1878.
1.01	4.40	56	.01	.00	.01	18.	1.01	16.40	200	.29	.29	.00	1722.
1.01	4.45	57	.01	.00	.01	19.	1.01	16.45	201	.29	.29	.00	1608.
1.01	4.50	58	.01	.01	.01	19.	1.01	16.50	202	.29	.29	.00	1524.
1.01	4.55	59	.01	.01	.01	20.	1.01	16.55	203	.29	.29	.00	1464.
1.01	5.00	60	.01	.01	.01	20.	1.01	17.00	204	.29	.29	.00	1419.
1.01	5.05	61	.01	.01	.01	21.	1.01	17.05	205	.23	.23	.00	1383.
1.01	5.10	62	.01	.01	.01	21.	1.01	17.10	206	.23	.23	.00	1348.
1.01	5.15	63	.01	.01	.01	22.	1.01	17.15	207	.23	.23	.00	1307.
1.01	5.20	64	.01	.01	.01	22.	1.01	17.20	208	.23	.23	.00	1260.
1.01	5.25	65	.01	.01	.01	23.	1.01	17.25	209	.23	.23	.00	1211.
1.01	5.30	66	.01	.01	.01	23.	1.01	17.30	210	.23	.23	.00	1164.
1.01	5.35	67	.01	.01	.01	24.	1.01	17.35	211	.23	.23	.00	1124.
1.01	5.40	68	.01	.01	.01	24.	1.01	17.40	212	.23	.23	.00	1092.
1.01	5.45	69	.01	.01	.01	25.	1.01	17.45	213	.23	.23	.00	1071.
1.01	5.50	70	.01	.01	.01	25.	1.01	17.50	214	.23	.23	.00	1056.
1.01	5.55	71	.01	.01	.01	25.	1.01	17.55	215	.23	.23	.00	1046.
1.01	6.00	72	.01	.01	.01	26.	1.01	18.00	216	.23	.23	.00	1038.
1.01	6.05	73	.07	.03	.03	28.	1.01	18.05	217	.02	.02	.00	1020.
1.01	6.10	74	.07	.03	.03	33.	1.01	18.10	218	.02	.02	.00	979.
1.01	6.15	75	.07	.04	.03	43.	1.01	18.15	219	.02	.02	.00	899.
1.01	6.20	76	.07	.04	.03	58.	1.01	18.20	220	.02	.02	.00	761.
1.01	6.25	77	.07	.04	.03	76.	1.01	18.25	221	.02	.02	.00	650.
1.01	6.30	78	.07	.04	.03	94.	1.01	18.30	222	.02	.02	.00	521.
1.01	6.35	79	.07	.04	.03	111.	1.01	18.35	223	.02	.02	.00	410.
1.01	6.40	80	.07	.04	.02	126.	1.01	18.40	224	.02	.02	.00	322.
1.01	6.45	81	.07	.04	.02	138.	1.01	18.45	225	.02	.02	.00	261.
1.01	6.50	82	.07	.04	.02	149.	1.01	18.50	226	.02	.02	.00	216.
1.01	6.55	83	.07	.04	.02	158.	1.01	18.55	227	.02	.02	.00	163.
1.01	7.00	84	.07	.05	.02	166.	1.01	19.00	228	.02	.02	.00	158.
1.01	7.05	85	.07	.05	.02	173.	1.01	19.05	229	.02	.02	.00	140.
1.01	7.10	86	.07	.05	.02	179.	1.01	19.10	230	.02	.02	.00	127.
1.01	7.15	87	.07	.05	.02	185.	1.01	19.15	231	.02	.02	.00	117.
1.01	7.20	88	.07	.05	.02	190.	1.01	19.20	232	.02	.02	.00	110.
1.01	7.25	89	.07	.05	.02	195.	1.01	19.25	233	.02	.02	.00	105.
1.01	7.30	90	.07	.05	.02	199.	1.01	19.30	234	.02	.02	.00	101.
1.01	7.35	91	.07	.05	.02	203.	1.01	19.35	235	.02	.02	.00	98.
1.01	7.40	92	.07	.05	.02	207.	1.01	19.40	236	.02	.02	.00	96.
1.01	7.45	93	.07	.05	.01	210.	1.01	19.45	237	.02	.02	.00	95.
1.01	7.50	94	.07	.05	.01	213.	1.01	19.50	238	.02	.02	.00	94.
1.01	7.55	95	.07	.05	.01	216.	1.01	19.55	239	.02	.02	.00	93.
1.01	8.00	96	.07	.05	.01	219.	1.01	20.00	240	.02	.02	.00	92.
1.01	8.05	97	.07	.05	.01	222.	1.01	20.05	241	.02	.02	.00	92.
1.01	8.10	98	.07	.05	.01	224.	1.01	20.10	242	.02	.02	.00	92.
1.01	8.15	99	.07	.05	.01	227.	1.01	20.15	243	.02	.02	.00	92.
1.01	8.20	100	.07	.05	.01	229.	1.01	20.20	244	.02	.02	.00	92.
1.01	8.25	101	.07	.05	.01	231.	1.01	20.25	245	.02	.02	.00	92.
1.01	8.30	102	.07	.06	.01	233.	1.01	20.30	246	.02	.02	.00	92.
1.01	8.35	103	.07	.06	.01	235.	1.01	20.35	247	.02	.02	.00	92.
1.01	8.40	104	.07	.06	.01	237.	1.01	20.40	248	.02	.02	.00	92.
1.01	8.45	105	.07	.06	.01	239.	1.01	20.45	249	.02	.02	.00	92.
1.01	8.50	106	.07	.06	.01	240.	1.01	20.50	250	.02	.02	.00	92.
1.01	8.55	107	.07	.06	.01	242.	1.01	20.55	251	.02	.02	.00	92.
1.01	9.00	108	.07	.06	.01	243.	1.01	21.00	252	.02	.02	.00	92.
1.01	9.05	109	.07	.06	.01	245.	1.01	21.05	253	.02	.02	.00	92.

1.01	8.50	106	.07	.06	.01	240.	1.01	20.50	250	.02	.02	.00	92.
1.01	8.55	107	.07	.06	.01	242.	1.01	20.55	251	.02	.02	.00	92.
1.01	9.00	108	.07	.06	.01	243.	1.01	21.00	252	.02	.02	.00	92.
1.01	9.05	109	.07	.06	.01	245.	1.01	21.05	253	.02	.02	.00	92.

1.01	9.10	110	.07	.06	.01	246.	1.01	21.10	254	.02	.02	.00	92.
1.01	9.15	111	.07	.06	.01	247.	1.01	21.15	255	.02	.02	.00	92.
1.01	9.20	112	.07	.06	.01	248.	1.01	21.20	256	.02	.02	.00	92.
1.01	9.25	113	.07	.06	.01	250.	1.01	21.25	257	.02	.02	.00	92.
1.01	9.30	114	.07	.06	.01	251.	1.01	21.30	258	.02	.02	.00	92.
1.01	9.35	115	.07	.06	.01	252.	1.01	21.35	259	.02	.02	.00	92.
1.01	9.40	116	.07	.06	.01	253.	1.01	21.40	260	.02	.02	.00	92.
1.01	9.45	117	.07	.06	.01	254.	1.01	21.45	261	.02	.02	.00	92.
1.01	9.50	118	.07	.06	.01	255.	1.01	21.50	262	.02	.02	.00	92.
1.01	9.55	119	.07	.06	.01	256.	1.01	21.55	263	.02	.02	.00	92.
1.01	10.00	120	.07	.06	.01	257.	1.01	22.00	264	.02	.02	.00	92.
1.01	10.05	121	.07	.06	.01	258.	1.01	22.05	265	.02	.02	.00	92.
1.01	10.10	122	.07	.06	.01	258.	1.01	22.10	266	.02	.02	.00	92.
1.01	10.15	123	.07	.06	.01	259.	1.01	22.15	267	.02	.02	.00	92.
1.01	10.20	124	.07	.06	.01	260.	1.01	22.20	268	.02	.02	.00	92.
1.01	10.25	125	.07	.06	.01	261.	1.01	22.25	269	.02	.02	.00	92.
1.01	10.30	126	.07	.06	.01	262.	1.01	22.30	270	.02	.02	.00	92.
1.01	10.35	127	.07	.06	.01	262.	1.01	22.35	271	.02	.02	.00	92.
1.01	10.40	128	.07	.06	.01	263.	1.01	22.40	272	.02	.02	.00	92.
1.01	10.45	129	.07	.06	.01	264.	1.01	22.45	273	.02	.02	.00	92.
1.01	10.50	130	.07	.06	.01	264.	1.01	22.50	274	.02	.02	.00	92.
1.01	10.55	131	.07	.06	.01	265.	1.01	22.55	275	.02	.02	.00	92.
1.01	11.00	132	.07	.06	.01	265.	1.01	23.00	276	.02	.02	.00	92.
1.01	11.05	133	.07	.06	.01	266.	1.01	23.05	277	.02	.02	.00	92.
1.01	11.10	134	.07	.06	.00	266.	1.01	23.10	278	.02	.02	.00	92.
1.01	11.15	135	.07	.06	.00	267.	1.01	23.15	279	.02	.02	.00	92.
1.01	11.20	136	.07	.06	.00	267.	1.01	23.20	280	.02	.02	.00	92.
1.01	11.25	137	.07	.06	.00	268.	1.01	23.25	281	.02	.02	.00	92.
1.01	11.30	138	.07	.06	.00	269.	1.01	23.30	282	.02	.02	.00	92.
1.01	11.35	139	.07	.06	.00	269.	1.01	23.35	283	.02	.02	.00	92.
1.01	11.40	140	.07	.06	.00	269.	1.01	23.40	284	.02	.02	.00	92.
1.01	11.45	141	.07	.06	.00	270.	1.01	23.45	285	.02	.02	.00	92.
1.01	11.50	142	.07	.06	.00	270.	1.01	23.50	286	.02	.02	.00	92.
1.01	11.55	143	.07	.06	.00	271.	1.01	23.55	287	.02	.02	.00	92.
1.01	12.00	144	.07	.06	.00	271.	1.02	.00	288	.02	.02	.00	92.

SUM 32.50 30.47 2.03 133928.
(825.)(774.)(51.)(3792.42)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4523.	1499.	465.	465.	133664.
CMS	128.	42.	13.	13.	3791.
INCHES		24.46	30.34	30.34	30.34
MM		621.18	770.69	770.69	770.69
AC-FT		743.	922.	922.	922.
THOUS CU M		917.	1137.	1137.	1137.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	673.	225.	70.	70.	20090.
CMS	19.	6.	2.	2.	569.
INCHES		3.67	4.55	4.55	4.55
MM		93.18	115.60	115.60	115.60

CMS	19.	6.	2.	2.	569.
INCHES		3.67	4.55	4.55	4.55
MM		93.18	115.60	115.60	115.60

AC-FT		111.	139.	138.	138.
THOUS CU M		137.	171.	171.	171.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	935.	300.	93.	93.	26773.
CMS	26.	8.	3.	3.	758.
INCHES		4.89	6.07	6.07	6.07
MM		124.24	154.14	154.14	154.14
AC-FT		149.	184.	184.	184.
THOUS CU M		183.	227.	227.	227.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2261.	749.	232.	232.	65932.
CMS	64.	21.	7.	7.	1895.
INCHES		12.23	15.17	15.17	15.17
MM		310.59	385.35	385.35	385.35
AC-FT		372.	461.	461.	461.
THOUS CU M		456.	569.	569.	569.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	4523.	1499.	465.	465.	133864.
CMS	128.	42.	13.	13.	3791.
INCHES		24.46	30.34	30.34	30.34
MM		621.18	770.69	770.69	770.69
AC-FT		743.	922.	922.	922.
THOUS CU M		917.	1137.	1137.	1137.

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HYDROGRAPH ROUTING

ROUTE THROUGH SPILLWAY

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
.0	.000	.00	1	1	0	0	0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
.0	.000	.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	.000	.000	.000	-546.	0

SURFACE AREA=	0.	9.	25.	53.
CAPACITY=	0.	74.	295.	1057.
ELEVATION=	521.	546.	560.	580.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
546.0	.0	.0	.0	.0	.0	.0	.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
549.6	.0	.0	0.

CREST LENGTH AT OR BELOW	0.	20.	29.	46.	105.	160.	238.	312.	483.	546.
ELEVATION	546.0	546.2	548.5	549.3	549.7	549.8	550.4	550.9	551.1	551.4

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
1.	1.	1.	2.	2.	3.	4.	4.	5.	6.
7.	7.	8.	9.	10.	11.	12.	13.	14.	14.
15.	16.	17.	18.	19.	20.	20.	21.	22.	23.
23.	24.	25.	25.	26.	27.	27.	28.	28.	29.
29.	30.	30.	31.	31.	32.	32.	32.	33.	33.
34.	34.	34.	35.	35.	35.	35.	36.	36.	36.
36.	37.	37.	37.	37.	38.	38.	40.	42.	44.
47.	51.	55.	60.	64.	68.	73.	77.	81.	85.
90.	94.	99.	103.	107.	112.	116.	120.	123.	127.
130.	134.	138.	142.	146.	150.	154.	159.	163.	166.
170.	173.	176.	178.	181.	186.	194.	210.	237.	274.
317.	361.	397.	423.	434.	435.	428.	415.	400.	383.
366.	350.	335.	321.	308.	296.	285.	275.	265.	255.
246.	236.	230.	223.	216.	210.	204.	199.	193.	186.
179.	170.	160.	151.	141.	131.	123.	114.	107.	100.
93.	87.	82.	77.	72.	68.	64.	61.	57.	54.
52.	49.	47.	45.	43.	41.	39.	38.	36.	35.
34.	33.	32.	31.	30.	29.	28.	27.	27.	26.
25.	25.	24.	24.	23.	23.	22.	22.	21.	21.
21.	20.	20.	20.	20.	19.	19.	19.	19.	18.
18.	18.	18.	18.	17.	17.	17.	17.		

STORAGE

72.	72.	72.	72.	72.	72.	72.	72.	72.	72.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS			
OPERATION	STATION	AREA	PLAN	RATIO 1 .15	RATIO 2 .20	RATIO 3 .50	RATIO 4 1.00
HYDROGRAPH AT	1	.57 (1.48)	1	678. (19.21)(	905. 25.61)(	2261. 64.04)(	4523. 128.07)(
ROUTED TO	2	.57 (1.48)	1	435. (12.32)(	638. 18.07)(	2156. 61.06)(	4471. 126.61)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	546.00	546.20	549.60
STORAGE	72.	72.	109.
OUTFLOW	0.	0.	513.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.15	549.30	.00	105.	435.	.00	16.33	.00
.20	549.91	.31	112.	638.	.58	16.25	.00
.50	551.21	1.61	129.	2156.	3.92	16.08	.00
1.00	552.06	2.46	141.	4471.	5.92	16.00	.00

END

DATE

FILMED

11-81

DTIC